National Park Service
U.S. Department of the Interior

Southeast Coast Network
Atlanta, Georgia

Appendix II: Air Resources of the Southeast Coast Network

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Executive Summary

The National Park Service's Air Quality Division has implemented monitoring efforts in many Class 1 units, but considerably more work needs to be done if the Service is to effectively detect and respond to threats to air resources. As part of the Natural Resource Inventory and Monitoring Program, the location of EPA air quality monitoring stations within close proximity (50-100 km) to park boundaries will be noted and summarized in an air quality atlas. Data from these stations can be used to obtain a rough assessment of air quality within individual park units. Information on visibility goals and air quality-related values will also be included in the inventory. Precipitation and meteorological data in the inventory consist of basic information on annual precipitation, relative humidity, wind speed and direction, and maximum and minimum daily temperatures.

The NPS Air Resources Division (ARD) contracted with the University of Denver (DU) to produce GIS-based maps and an associated look-up table that provide baseline values for a set of air quality parameters for all Inventory and Monitoring parks in the U.S. These maps and table will serve as the Air Inventory for the parks. Air Quality Inventory products are available on the Internet at http://www2.nature.nps.gov/ard/gas/ (see section called Air Atlas). ARD used preliminary DU products to help develop a strategy for expanding ARD-funded ambient air quality monitoring with increased funding from the Natural Resources Challenge in FY 2002. At this time, ARD does not intend to fund additional monitoring at any NPS units in the Southeast Coast Network. The ARD air monitoring strategy will be revisited in FY 2004 if additional funding becomes available.

Data from the Air Quality Inventory, national air monitoring programs described below, and other air quality sources, were used in conjunction with park-specific resource information to evaluate the following needs relative to the Southeast Coast Network: 1) the need for additional ambient air quality monitoring at any Network park, i.e., wet deposition, dry deposition, visibility, particulate matter and/or ozone monitoring, and 2) the need for air quality effects-related monitoring at any Network park. The results of this evaluation, as well as a brief summary of results

of past air quality monitoring at relevant sites, are discussed below.

Wet Deposition

The National Atmospheric Deposition Program/National Trends Network (NADP/NTN) is a nationwide network of precipitation monitoring sites. The network is a cooperative effort between many different groups, including the U.S. Environmental Protection Agency (EPA), U.S. Geological Survey, U.S. Department of Agriculture, and private entities. The NPS is a major participant in NADP/NTN, and the ARD recommends that any new wet deposition site installed in a park meet NADP/NTN siting criteria and follow NADP/NTN protocols. There are currently more than 200 NADP/NTN sites spanning the continental U.S., Alaska, Puerto Rico, and the Virgin Islands.

The purpose of the network is to collect data on the chemistry of precipitation to monitor geographical and temporal long-term trends. The precipitation at each station is collected weekly according to strict clean-handling procedures. It is then sent to the Central Analytical Laboratory in Illinois where it is analyzed for hydrogen (acidity as pH), sulfate, nitrate, ammonium, chloride, and base cations (such as calcium, magnesium, potassium and sodium). NADP/NTN's excellent quality assurance programs ensure that the data remain accurate and precise. The National Atmospheric Deposition Program has also expanded its sampling to include the Mercury Deposition Network (MDN), which currently has over 80 sites. The MDN was formed in 1995 to collect weekly samples of precipitation, which are analyzed for total mercury. The objective of the MDN is to monitor the amount of mercury in precipitation on a regional basis.

None of the Southeast Coast Network parks have an NADP/NTN monitor on-site; all have a monitor within 85 miles. Distance, as well as terrain, intervening pollution sources, and differences in meteorology affect how well a monitoring site's data represent conditions at a park. Meteorology is an important consideration for coastal parks, since wind patterns on the coast can be very different from those inland. Nevertheless, based on a rough evaluation of these factors, it appears that all Network parks are well represented by existing NADP/NTN monitors.

There are currently nine MDN sites in the Southeast Coast Network area, including one at Congaree National Park in South Carolina (site #SC19). Other stations are located at Centreville, Alabama (site #AL03); Chassahowitzka National Wildlife Refuge (NWR), Florida (site #FL05); Okefenokee NWR, Georgia (site #GA09); Fulton County, Georgia (site #GA22); Yorkville, Georgia (site #GA40); Lake Waccamaw State Park, North Carolina (site #NC08); Pettigrew State Park, North Carolina (site #NC42); and Barnwell County, South Carolina (site #SC03). MDN sites will be initiated in 2003 in Orlando, Florida (site #FL97) and Cape Romain NWR, South Carolina (site #SC05).

Deposition varies with the amount of annual on-site precipitation, and is useful because it gives an indication of the total annual pollutant loading at the site. Concentration is independent of precipitation amount, therefore, it provides a better indication of whether ambient pollutant levels are increasing or decreasing over the years. In general, annual average wet deposition and concentration of sulfate, nitrate, and ammonium are higher in the eastern than in the western U.S. (Figure A11-1, Figure A11-2; also see NADP/NTN maps at http://nadp.sws.uiuc.edu). At many NADP/NTN sites across the U.S., concentration and deposition of sulfate have declined in recent years as sulfur dioxide emissions have decreased. Trends have been variable for nitrate and ammonium, with concentration and deposition at various sites increasing, decreasing, or showing no overall change. Results from NADP/NTN sites in and near Southeast Coast Network parks are summarized below. Both the Clinton, North Carolina, and Santee NWR, South Carolina, sites show an increase in wet ammonium concentration that may be due to increased hog farming in the area.

MDN sites within the Southeast Coast Network are as follows:

Crossville, AL The Crossville, Alabama, NADP/NTN site at Sand Mountain Experiment Station (site #AL99) was installed in 1984. Wet concentration and deposition of sulfate have decreased at the site, while wet

concentration of ammonium, wet concentration of nitrate, and wet deposition of nitrate have increased. There has been no overall trend in wet ammonium deposition.

Dallas County, AL A NADP/NTN site has been operating in Dallas County, Alabama (site #AL10 (Black Belt Substation)) since 1983. Site data show a decrease in concentration and deposition of wet sulfate, but no overall trends in concentration and deposition of wet nitrate and wet ammonium.

Kennedy Space Center, FL The NADP/NTN site at Kennedy Space Center, Florida (site #FL99) has been operating since 1983. Site data show an increase in concentration and deposition of wet nitrate and wet ammonium, but no overall trends in concentration and deposition of wet sulfate.

Sampson City, FL A NADP/NTN site has been operating at Sampson City, Florida (site #FL03 (Bradford Forest)) since 1978. Site data show a decrease in concentration and deposition of wet sulfate, but no overall trends in concentration and deposition of wet nitrate and wet ammonium.

Okefenokee NWR, GA A NADP/NTN site was installed at Okefenokee NWR, Georgia (site #GA09) in 1997. Trend data are not yet available from the site.

Pike County, GA The Pike County, Georgia, NADP/NTN site (site #GA41 (Georgia Station)) has been operating since 1978. Site data show a decrease in concentration and deposition of wet sulfate, but no overall trends in concentration and deposition of wet nitrate and wet ammonium.

Sapelo Island, GA A NADP/NTN site was installed at Sapelo Island, Georgia (site #GA33) in 2002. Data are not yet available from the site.

Skidaway, GA A NADP/NTN site was installed at Skidaway, Georgia (site #GA98) in 2002. Data are not yet available from the site.

Beaufort, NC A NADP/NTN site was installed at Beaufort, North Carolina (site #NC06) in 1999. Trend data are not yet available from the site.

Clinton, NC A NADP/NTN site has been operating at Clinton, North Carolina (site #NC35) since 1978. Site data show a decrease in concentration and deposition of wet sulfate and no overall trend in concentration and deposition of wet nitrate. Concentration of wet ammonium has increased, with a substantial upward trend since 1993. Deposition of wet ammonium has increased since 1987.

Cape Romain NWR, SC A NADP/NTN site was installed at Cape Romain NWR, South Carolina (site #SC05) in 2000. Data are not yet available from the site.

Fort Johnson, SC A NADP/NTN site was installed at Fort Johnson, South Carolina (site #SC99) in 2002. Data are not yet available from the site.

Santee NWR, SC A NADP/NTN site was installed at Santee NWR, South Carolina (site #SC06) in 1984. Site data show a decrease in wet sulfate concentration, but no trend in wet sulfate deposition. There has been no trend in wet nitrate concentration or deposition. There has been an increasing trend in wet ammonium concentration and deposition.

Dry Deposition

The Clean Air Status and Trends Network (CASTNet) is considered the nation's primary source for atmospheric data to estimate dry acidic deposition. Established in 1987, CASTNet now comprises over 70 monitoring stations across the U.S. The majority of the monitoring stations are operated by EPA; however, approximately 20 stations are operated by the NPS in cooperation with EPA. Each CASTNet dry deposition station measures: weekly average atmospheric concentrations of sulfate, nitrate, ammonium, sulfur dioxide, and nitric acid; hourly concentrations of

ambient ozone; and meteorological conditions required for calculating dry deposition rates. Dry deposition rates are calculated using atmospheric concentrations, meteorological data, and information on land use, vegetation, and surface conditions. CASTNet complements the database compiled by NADP/NTN. Because of the interdependence of wet and dry deposition, NADP/NTN wet deposition data are collected at or near all CASTNet sites. Together, these two long-term databases provide the necessary data to estimate trends and spatial patterns in total atmospheric deposition. The ARD recommends that all new dry deposition sites installed in parks use CASTNet siting criteria and follow CASTNet protocols.

None of the Southeast Coast Network parks have a CASTNet monitor on site. Nine of the parks have a monitor within 120 miles that can provide representative data. Eight parks (Castillo de San Marcos National Monument (NM), Cumberland Island National Seashore (NS), Fort Caroline National Memorial (NMem), Fort Frederica NM, Fort Pulaski NM, Fort Matanzas NM, Fort Sumter NM and Timucuan Ecological and Historic Reserve) have no representative dry deposition data. However, given the expense of dry deposition monitoring, unless there is a need to better quantify dry deposition in a park, the ARD does not recommend the Network fund CASTNet monitoring.

Because CASTNet uses different monitoring and reporting techniques than NADP/NTN, the dry deposition amounts are reported here as nitrogen and sulfur, rather than nitrate, ammonium, and sulfate. In addition, because CASTNet calculates dry deposition based on measured ambient concentrations and estimated deposition velocities, there is greater uncertainty in the reported values. Due to the small number of CASTNet sites nationwide, use of dry deposition isopleth maps is not advised at this time. CASTNet data collected at sites closest to Southeast Coast Network parks are as follows:

Crossville, AL: The Crossville, Alabama, CASTNet site (site #SND152 (Sand Mountain Experiment Station)) has been in operation since 1988. There has been a decrease in dry sulfur deposition at the site, but no trend in dry nitrogen deposition. Total nitrogen deposition at the site is composed of 36 percent dry deposition and 64 percent wet deposition, while total sulfur deposition is 41 percent dry and 59 percent wet.

Indian River, FL: A CASTNet monitor was installed in Indian River County, Florida (site #IRL141) in 2001. Data are not yet available from the site.

Pike County, GA: The Pike County, Georgia, CASTNet site (site #GAS153 (Georgia Station)) has been operating since 1989. Site data indicate an increase in dry nitrogen deposition, and a decrease in dry sulfur deposition. Total nitrogen deposition at the site is estimated to be 58 percent wet and 42 percent dry; total sulfur deposition has the same percentages.

Beaufort, NC: A CASTNet site was installed at Beaufort, North Carolina (site #BFT142) in 1994. Data indicate no trends in dry nitrogen or sulfur deposition. Total nitrogen deposition at the site is estimated to be 68 percent wet and 32 percent dry, while total sulfur deposition is 64 percent wet and 36 percent dry.

Candor, NC: A CASTNet site has been operating at Candor, North Carolina (site #CND125) since 1990. Site data indicate no trends in dry nitrogen or sulfur deposition. CASTNet estimates total nitrogen deposition at the site is composed of 37 percent dry deposition and 63 percent wet deposition, while total sulfur deposition is 34 percent dry and 66 percent wet.

Air Toxics

Air toxics, e.g., mercury, dioxins, and benzene, may be a concern for Network parks, particularly those that are located near urban areas. Some states conduct air toxics monitoring. In most cases, the monitoring is focused primarily on urban areas and/or industrial sites. The air agencies in states with Southeast Coast Network parks were contacted regarding current and planned air toxics monitoring. The results are summarized below.

Alabama Contact: Elvin Lang, 334-271-7905. Alabama currently monitors airborne mercury near Mobile. The state may expand their toxics monitoring program in the future.

Florida Contact: Caroline Shire, Central District, 407-894-7555 and Air Program, Duvall County, 904-630-4900. According to Caroline Shire, no air toxics monitoring is conducted near Canaveral NS, and no toxics monitoring sites are planned at this time. There are two air toxics monitors currently located in Jacksonville, and three more will be installed in the near future. Site descriptions and some data from a 2001 study are available on the Duval County website (http://www.coj.net/Departments/Regulatory+and+Environmental+Services/Air+and+Water+Quality/Lab+Services.htm).

Georgia Contact: Susan Zimmer-Dauphinee, 404-363-7079. Georgia has a long history of air toxics monitoring, and monitoring has taken place in a number of locations around the state. The state prepares annual reports on its toxics monitoring program. Copies of the reports are available from Susan Zimmer-Dauphinee. Current monitoring locations include Utoy Creek in Atlanta (Chattahoochee River National Recreation Area), Brunswick (Cumberland Island NS and Fort Frederica NM), Dawsonville (Chattahoochee River NRA), Macon (Ocmulgee NM), Savannah (Fort Pulaski NM), Tucker (Chattahoochee River NRA), and Yorkville (Kennesaw Mountain National Battlefield Park (NBP)).

North Carolina Contact: Julie Kinlaw, 919-733-3843. The state conducts air toxics monitoring in a number of locations, but none are near Southeast Coast Network parks. There are no plans to add additional sites to the state's toxics monitoring program in the near future.

South Carolina Contact: Robert Schilling, 803-896-0907. The state monitors air toxics in a number of locations, including Charleston (Fort Sumter NM) and Columbia (Congaree National Park). No additional toxics monitoring sites are planned at this time.

Surface Water Chemistry

The Water Resources Division's Baseline Water Quality Data Inventory and Analysis reports were reviewed for all Southeast Coast Network parks except Chattahoochee River NRA and Fort Sumter NM. Air pollution concerns relative to surface water chemistry include acidification due to sulfur and nitrogen deposition in fresh water, eutrophication from excess nitrogen deposition in fresh or saline water, and deposition of toxic air pollutants such as mercury, other metals, and organics. In general, acid-sensitive surface waters have a pH below 6.0 and an acid neutralizing capacity (ANC) below 100 microequivalents per liter (µeq/l). Results for the Network parks are summarized below.

CAHA – The 1994 Baseline Water Quality Data Inventory and Analysis report for Cape Hatteras NS suggests that all surface waters associated with the park are either saline or tidally influenced (National Park Service 1994d). If this is the case, then surface water acidification is not a concern for the park. The report did not indicate that nitrogen-associated eutrophication was an issue.

CANA – The 1996 Baseline Water Quality Data Inventory and Analysis report for Canaveral NS suggests that all surface waters associated with the park are either saline or tidally influenced (National Park Service 1994c). If this is the case, then surface water acidification is not a concern for the park. The report did not indicate that nitrogen-associated eutrophication was an issue.

CALO – The 1995 Baseline Water Quality Data Inventory and Analysis report for Cape Lookout NS suggests that all surface waters associated with the park are either saline or tidally influenced (National Park Service 1994e). If this is the case, then surface water acidification is not a concern for the park. The report did not indicate that nitrogen-associated eutrophication was an issue.

CASA / FOMA – The 1998 Baseline Water Quality Data Inventory and Analysis report for Castillo de San Marcos NM suggests that all surface waters associated with the park are either saline or tidally influenced (National Park Service 1994f). If this is the case, then surface water acidification is not a concern for the park. The report did not indicate that nitrogen-associated eutrophication was an issue.

The 1999 Baseline Water Quality Data Inventory and Analysis report for Fort Matanzas NM suggests that all surface waters associated with the park are either saline or tidally influenced (National Park Service 1994b). If this is the case, then surface water acidification is not a concern for the park. The report did not indicate that nitrogen-associated eutrophication was an issue.

CONG – The 1998 Baseline Water Quality Data Inventory and Analysis report for Congaree National Park contains data collected in the park from 1992 to 1997 (National Park Service 1998a). Samples collected in Lower Tom's Creek, Cedar Creek, and the Congaree River had average pH values of 5.9 to 6.5, with a minimum pH of 5.1. The average ANC value on Cedar Creek was 38 µeq/l, and the minimum value was 16 µeq/l. The average ANC on the Congaree River was 160 µeq/l and the minimum value was 64 µeq/l. Weston and Wise Lakes also had low pH values, with an average pH of 5.9 and a minimum of 4.0. These data indicate surface waters in Congaree National Park are extremely acid sensitive, and it's possible that they currently experience episodic acidification, i.e., precipitation events that cause the creeks and lakes to lose all buffering capacity for a short amount of time. There is no indication that nitrogen-associated eutrophication is an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

CUIS – The 1997 Baseline Water Quality Data Inventory and Analysis report for Cumberland Island NS shows that no water chemistry data have been collected in the park (National Park Service 1994a). There is no indication that nitrogen-associated eutrophication is an issue.

FOFR – The 1998 Fort Frederica NM Baseline Water Quality Data Inventory and Analysis report indicates no water quality data have been collected in the park, and no pH or ANC data are available for the study area (National Park Service 1998b). Nevertheless, based on the description of the park on the Fort Frederica NM website, it doesn't appear this surface water acidification is a concern for the park. There is no indication that nitrogen-associated eutrophication is an issue.

FOPU – The 2001 Baseline Water Quality Data Inventory and Analysis report for Fort Pulaski NM includes data collected in the park from 1971 to 1998 (National Park Service 2001). The feeder canal and Savannah River had average pH values of 7.3, and the Wilmington River had a pH of 6.5. The Savannah River had an average ANC of 504 µeq/l, and the Wilmington River had an ANC of 216 µeq/l. These data indicate surface waters in the park are not sensitive to acidification from atmospheric deposition. The report did not indicate that nitrogen-associated eutrophication was an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

HOBE – The 1997 Baseline Water Quality Data Inventory and Analysis report for Horseshoe Bend National Military Park (NMP) includes data collected in the park from the Tallapoosa River and its tributaries between 1994 and 1997. The data show an average pH of 6.7 and an average ANC of about 300 µeq/l. The data indicate surface waters in the park are not sensitive to acidification from atmospheric deposition. The report did not indicate that nitrogen-associated eutrophication was an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

KEMO – The 1997 Baseline Water Quality Data Inventory and Analysis report for Kennesaw Mountain NBP includes data collected in the park from John Ward Creek and Noses Creek from 1993 to 1997. The creeks had an average pH of 6.6, with a minimum of 6.0. While it's not possible to accurately assess acid

sensitivity without ANC data, the average pH values suggest the creeks are not likely to be sensitive to acidification from atmospheric deposition. There is no indication that nitrogen-associated eutrophication is an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

MOCR – The 1997 Baseline Water Quality Data Inventory and Analysis report for Moores Creek National Battlefield (NB) says some surface waters in the study area have been affected by mining activities. This may be the case for Moores Creek, because samples collected from 1985 to 1996 had an average pH of 5.8 (4.9 minimum) and an average ANC of 40 µeq/l (range of 16-120 µeq/l). These data indicate Moores Creek is extremely acid sensitive, and it's possible that the creek currently experiences episodic acidification. There is no indication that nitrogen-associated eutrophication is an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

OCMU – The 2002 Baseline Water Quality Data Inventory and Analysis report for Ocmulgee NM includes data collected in the park from Walnut Creek and an unnamed creek in 1994 and 1995 (National Park Service 2002b). The creeks had an average pH of about 6.6, with a minimum of 6.2. While it's not possible to accurately assess acid sensitivity without ANC data, the average pH values suggest the creeks are not likely to be sensitive to acidification from atmospheric deposition. There is no indication that nitrogen-associated eutrophication is an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

TIMU/FOCA – The 2002 Baseline Water Quality Data Inventory and Analysis report for Fort Caroline NMem shows Spanish Pond was sampled in 1997 and 1998 (National Park Service 2002a). The pond had an average pH of 6.4 with a minimum value of 5.8. While it's not possible to accurately assess acid sensitivity without ANC data, the average pH values suggest the pond is not likely to be sensitive to acidification from atmospheric deposition. All other surface waters associated with the park appear to be either saline or tidally influenced. If this is the case, then surface water acidification is not a concern for the park. There is no indication that nitrogen-associated eutrophication is an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

The 2002 Baseline Water Quality Data Inventory and Analysis report for Timucuan Ecological and Historic Reserve appeared to contain data only for surface waters that are either saline or tidally influenced. If fresh water occurs in the park, its sensitivity to acidification is unknown. There is no indication that nitrogen-associated eutrophication is an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

Particulate Matter

Small or "fine" particles in the air, typically those less than 2.5 micrometers in diameter, $PM_{2.5}$, are a leading cause of human respiratory illness. Particles are present everywhere, but high concentrations and/or specific types have been found to present a serious danger to human health. Fine particles in the air are the main contributor to human-caused visibility impairment. The particles not only decrease the distance one can see; they also reduce the colors and clarity of scenic vistas. Moisture in the air enhances the impact, so areas in the Eastern U.S., with higher relative humidity, have worse visibility than areas in the arid West (see attached Air Inventory map). In 1997, EPA finalized new stricter, human-health based, National Ambient Air Quality Standards (NAAQS) for particulate matter. Original NAAQS for particulate matter were for those particles 10 microns or less (PM_{10}). The new national standards now regulate $PM_{2.5}$.

Fort Sumter NM has a PM_{10} monitor on-site, all other Southeast Coast Network parks have representative data collected within 35 miles. None of the states with Southeast Coast Network parks have areas currently designated nonattainment for PM_{10}. Nationwide $PM_{2.5}$ monitoring was initiated in 1999; nonattainment areas will not be designated until 2004. 1999-2001 data indicate coastal Southeast Coast Network parks will be in attainment for $PM_{2.5}$, but non-coastal parks will likely be nonattainment.

In 1985, in response to the mandates of the Clean Air Act, Federal and regional/state organizations established the Interagency Monitoring of Protected Visual Environments (IMPROVE) program to protect visibility in Class I air quality areas. Class I areas are national parks greater than 5,000 acres and wilderness areas greater than 6,000 acres, that were established prior to August 7, 1977. All other NPS areas are designated Class II. The objectives of the IMPROVE program are: to establish current visibility conditions in all Class I areas; to identify pollutants (particles and gases) and emission sources responsible for existing man-made visibility impairment; and to document long-term trends in visibility. In 1999, there were 30 official IMPROVE sites and 40 protocol sites. Because of recently enacted regulations that require improving visibility in Class I areas, the number of visibility monitors is increasing. Protocol sites are being upgraded to full IMPROVE sites and 80 new sites are being added to the IMPROVE network.

While the IMPROVE program has focused on Class I air quality areas, a great deal of visibility monitoring has been conducted in Class II areas. The ARD recommends that new visibility monitoring in NPS areas be conducted in coordination with the IMPROVE program (the IMPROVE program is managed out of the NPS ARD office in Fort Collins, Colorado). Some I&M Networks are considering monitoring visibility at scenic vistas with digital cameras. While this type of monitoring would not be adequate for regulatory purposes, it is useful for documenting visibility conditions and trends and provides an excellent means of sharing that information with the public.

None of the Southeast Coast Network parks have an IMPROVE monitor on site. Eleven parks have IMPROVE sites within 100 miles that can provide representative data. There are no nearby, Atlantic coast IMPROVE sites to provide data for Canaveral NS, Casa de San Marcos NM or Fort Matanzas NM, and there are no nearby inland sites for Horseshoe Bend NMP, Moores Creek NB or Ocmulgee NM. IMPROVE sites have been operating at Cape Romain NWR, South Carolina, since 1994 (site #ROMA); at Chassahowitzka NWR, Florida, since 1993 (site #CHAS); at Okefenokee NWR, Georgia, since 1991 (site #OKEF); and at Sipsey Wilderness Area (WA), Alabama, since 1992 (site #SIPS). Sites were installed at Cohutta WA, Georgia (site #COHU) and Swanquarter NWR, North Carolina (site #SWAN) in 2000.

Long-term visibility trends have not yet been determined for any IMPROVE sites in the Southeast Coast Network area. As for the sources of visibility impairment, 1996-1998 aerosol data from the four long-term sites show that, on an annual basis, visibility impairment is primarily due to sulfates (sources include coal combustion and oil refineries), then organics (sources include automobiles and chemical manufacturing), then soil (from windblown dust), then light absorbing carbon (sources include wood burning), and then nitrates (sources include coal and natural gas combustion and automobiles). At all sites, visibility was best in the winter and worst in the summer.

Ozone

Congaree National Park and Fort Sumter NM have ozone monitors on-site, the rest of the Southeast Coast Network parks have one or more ozone monitors within 35 miles. Chattahoochee River NRA, Congaree National Park, Kennesaw Mountain NBP, and Ocmulgee NM are in areas that will likely be designated nonattainment under EPA's new human-health based 8-hour NAAQS (Figure A11-3, Figure A11-4, Figure A11-5, Figure A11-6, Figure A11-7).

With the exception of CONG and FOSU, ambient concentrations of ozone were not monitored on-site, but were estimated by Krieging, a statistical interpolation process. The estimated hourly concentrations of ozone were then used to generate annual exposure values for the site (National Park Service 2004). The exposure values include the

Sum06 and W126 exposure indices in ppm-hr and the annual number of hours above 60, 80 and 100 ppb (N60, N80 and N100, respectively).

The uptake of ambient ozone by a plant is highly dependent upon the environmental conditions under which the exposure takes place, and the level of soil moisture is an important environmental variable controlling the process. Understanding the soil moisture status can provide insight to how effective an exposure may be in leading to foliar injury. The Palmer Z Index was selected to indicate soil moisture status since it represents the short-term departure of soil moisture from the average for each month for the site. The objectives of the assessment were to examine the relationship between high annual levels of ozone and soil moisture status, and to consider the impact reduced soil moisture status would have on the effectiveness of exposure.

The Palmer Z Index is calculated for up to 10 regions within a state and therefore is not a site-specific index. Without site-specific data, ozone/soil moisture relationships can only be estimated. Site-specific criteria such as aspect, elevation, and soil type can alter soil moisture conditions such that they depart from those determined for the region. However, in lieu of site-specific data, the Palmer Z Index is the best estimate of short-term soil moisture status and its change throughout the growing season.

Palmer Z data were compiled for the site for both the three months used to calculate the Sum06 index and for the April through October period for the W126 index for 1995 through 1999. It was not possible to identify the specific 3-month summation period for the Sum 06 index since the index was obtained by Krieging. The summation period was estimated from the 3-month periods for Sum 06 indices calculated from monitored ozone data for sites within 50 km of the park. The Palmer Z index ranges from approximately +4.0 (extreme wetness) to –4.0 (extreme drought) with ±0.9 representing normal soil moisture.

CAHA: The risk of foliar ozone injury at Cape Hatteras National Seashore is moderate. The threshold level for injury is consistently satisfied by the Sum06 index, while the W126 index satisfies the criteria on occasion. The N-values indicate that in some years there are consistent exposures to concentrations of ozone greater than 80 ppb, and significant hours of exposure at 100 ppb. The lack of a relationship between level of ozone and soil moisture suggests that conditions favorable for the uptake of ozone occur independently of the levels of exposure. This creates the possibility of reaching the threshold for injury when high levels of exposure happen to coincide with favorable soil moisture conditions.

CANA: The low levels of ozone exposure and the relatively dry soil moisture conditions at Canaveral National Seashore make the risk of foliar ozone injury to plants low. Although the Sum06 exposures exceed the threshold levels for injury, the W126 do not since the N100 criterion is not satisfied. Soil moisture conditions of mild to severe drought reduce the effectiveness of the higher ozone exposures, and hourly concentrations of ozone only occasionally exceeded 80 ppb.

CALO: The risk of foliar ozone injury at Cape Lookout National Seashore is moderate. The threshold level for injury is consistently satisfied by the Sum06 index, while the W126 index satisfies the criteria on occasion. The N-values indicate that in some years there are consistent exposures to concentrations of ozone greater than 80 ppb, and significant hours of exposure at 100 ppb. The lack of a relationship between level of ozone and soil moisture suggests that conditions favorable for the uptake of ozone occur independently of the levels of exposure. This creates the possibility of reaching the threshold for injury when high levels of exposure happen to coincide with favorable soil moisture conditions such as 1996.

CASA / FOMA: The risk of foliar ozone injury at Castillo De San Marcos National Monument is moderate. The Sum06 threshold is satisfied annually while the W126 threshold is satisfied only in the highest exposure years. In these years, however, soil moisture levels are at mild to severe levels of drought that reduce the uptake of ozone. The N-values indicate that exposures to 80 to 100 ppb vary considerably among years. It

is anticipated that the risk of injury may be greatest in years when ambient levels of ozone are moderately high and soil moisture conditions favor uptake by plants. At present, no ozone-sensitive species have been identified at the site, and the risk remains unrealized.

The low levels of ozone exposure and the relatively dry soil moisture conditions at Fort Matanzas National Monument make the risk of foliar ozone injury to plants low. While the Sum06 exposures exceed the threshold levels for injury, the W126 do not since the N100 criterion is not satisfied. Since soil moisture conditions of mild to severe drought reduce the effectiveness of the higher exposures, and hourly concentrations of ozone seldom exceed 80 ppb, it is unlikely that foliar injury will be produced on plants.

CHAT: The risk of foliar ozone injury to plants at Chattahoochee River National Recreation Area is high. While the levels of ozone exposure consistently create the potential for injury, dry soil conditions may reduce the likelihood of injury in a particular year. However, levels of exposure capable of producing foliar injury also occur under conditions of minor drought. The probability of foliar injury developing may be greatest during years in which ozone levels are somewhat reduced but still exceed the thresholds, and soil moisture levels are normal or under mild drought and do not significantly constrain the uptake of ozone.

CONG: The risk of foliar ozone injury at the Congaree National Park is low. While the threshold level for injury is satisfied by the Sum06 index, the N-values indicate that there are only occasional exposures to concentrations of ozone greater than 80 ppb and exposures above 100 ppb are rare. Relationships between levels of ozone and soil moisture are inconsistent, but suggest that conditions limiting the uptake of ozone occur during most years and may be most prevalent during higher ozone years. It is anticipated that the risk of injury may be greatest in years when ambient levels of ozone are high and soil moisture conditions favor uptake by plants.

CUIS: The low levels of ozone exposure and the relatively dry soil moisture conditions at Cumberland Island National Seashore make the risk of foliar ozone injury to plants low. While the Sum06 exposures exceed the threshold levels for injury, the W126 do not since the N100 criterion is not satisfied. Since soil moisture conditions of mild to moderate drought reduce the effectiveness of the exposures, and hourly concentrations of ozone seldom exceeded 80 ppb, it is unlikely that foliar injury will be produced on plants.

FOFR: The low levels of ozone exposure and the relatively dry soil moisture conditions at Fort Frederica National Monument make the risk of foliar ozone injury to plants low. While the Sum06 exposures exceed the threshold levels for injury, the W126 do not since the N100 criterion is not satisfied. Since soil moisture conditions of mild to severe drought reduce the effectiveness of the higher exposures, and hourly concentrations of ozone seldom exceed 80 ppb, it is unlikely that foliar injury will be produced on plants.

FOPU: The low levels of ozone exposure and the relatively dry soil moisture conditions at Fort Pulaski National Monument make the risk of foliar ozone injury to plants low. While the Sum06 exposures exceed the threshold levels for injury, the W126 do not since the N100 criterion is not satisfied. Since soil moisture conditions of mild to severe drought reduce the effectiveness of the higher exposures, and hourly concentrations of ozone seldom exceeded 80 ppb, it is unlikely that foliar injury will be produced on plants.

FOSU: The low levels of ozone exposure and dry soil moisture conditions at Fort Sumter National Monument make the risk of foliar ozone injury to plants low. While the Sum06 index meets the criteria for injury, the W126 does not since the N100 criterion is not satisfied. Since periodic soil moisture conditions of mild to moderate drought reduce the effectiveness of the higher exposures, and hourly concentrations of ozone seldom exceed 80 ppb, it is unlikely that foliar injury will be produced on plants.

HOBE: The risk of foliar ozone injury to plants at Horseshoe Bend National Military Park is high. While the levels of ozone exposure generally create the potential for injury, low soil moisture may reduce the likelihood of injury developing in the higher ozone years. Because the site is subject to potentially harmful levels of

ozone in most years, the probability of foliar injury developing may be greatest during years in which ozone levels are somewhat reduced but still exceed the thresholds, and soil moisture levels are normal or under mild drought and do not significantly constrain the uptake of ozone.

KEMO: The risk of foliar ozone injury to plants at Kennesaw Mountain National Battlefield Park is high. While the levels of ozone exposure consistently create the potential for injury, low soil moisture may reduce the likelihood of injury developing in any particular year. Since the site is subject to potentially harmful levels of ozone annually, the probability of foliar injury developing may be greatest during years in which ozone exposures exceed the thresholds, and soil moisture levels are normal or under mild drought and do not significantly constrain the uptake of ozone.

MOCR: The risk of foliar ozone injury at Moore's Creek National Battlefield is moderate. The Sum06 threshold is satisfied annually while the W126 threshold is satisfied only in the highest exposure years. The N-values indicate that exposures to 80 to 100 ppb vary considerably among years. Months of low soil moisture occur independent of the level of ozone and can significantly constrain the uptake of ozone. It is anticipated that the risk of injury would be greatest in years when high levels of ozone happened to occur when soil moisture conditions favor its uptake by plants.

OCMU: The risk of foliar ozone injury to plants at Ocmulgee National Monument is high. The levels of ozone exposure consistently create the potential for injury, however dry soil conditions may reduce the likelihood of injury in a high exposure year. Levels of exposure capable of producing foliar injury also occur under conditions of minor drought and normal soil moisture. The probability of foliar injury developing may be greatest during years in which ozone levels are somewhat reduced but still exceed the thresholds, and soil moisture levels are normal or under mild drought and do not significantly constrain the uptake of ozone.

TIMU / FOCA: The low levels of ozone exposure and the relatively dry soil moisture conditions at Fort Caroline National Monument make the risk of foliar ozone injury to plants low. While the Sum06 exposures exceed the threshold levels for injury, the W126 do not since the N100 criterion is not satisfied. Since soil moisture conditions of mild to severe drought reduce the effectiveness of the higher exposures, and hourly concentrations of ozone seldom exceeded 80 ppb, it is unlikely that foliar injury will be produced on plants.

The low levels of ozone exposure and the periodically dry soil moisture conditions at Timucuan Ecological and Historic Preserve make the risk of foliar ozone injury to plants low. While the Sum06 exposures exceed the threshold level for injury, the W126 do not since the N100 criteria are not satisfied. High ozone exposures occur during periods of several continuous months of mild to severe drought significantly reduce their effectiveness. Hourly concentrations of ozone exceed 80 ppb for a few hours each year and are unlikely to produce foliar injury to plants.

Conclusions

None of the Southeast Coast Network parks have an NADP/NTN monitor on-site; all have a monitor within 85 miles. It is likely that all parks are well represented by existing monitors.

None of the Southeast Coast Network parks have a CASTNet monitor on site. Nine of the parks have a monitor within 120 miles that can provide representative data. Eight of the parks in Florida and coastal Georgia and South Carolina have no representative dry deposition data. However, given the expense of dry deposition monitoring, the existence of representative wet deposition data, and the fact that surface waters in these parks don't appear to be sensitive to atmospheric deposition, installation of a CASTNet monitor is not recommended.

Air toxics may be an issue for many Southeast Coast Network parks. States conduct air toxics monitoring near all parks except Canaveral NS, Cape Hatteras NS, Cape Lookout NS, Horseshoe Bend NMP, and Moores Creek NB.

Network staff may want to consider monitoring contaminants in biota in those parks where air toxics are a concern.

Park water quality data were reviewed for fifteen Southeast Coast Network parks. The data indicated surface waters at Congaree National Park and Moores Creek NB are extremely sensitive to acidification from atmospheric deposition. Network staff may want to consider long-term monitoring of acid deposition-related water chemistry parameters, such as pH and ANC, at these parks.

Fort Sumter NM has a PM_{10} monitor on-site, all other Southeast Coast Network parks have representative data collected within 35 miles.

None of the Southeast Coast Network parks have an IMPROVE monitor on site. Eleven parks have IMPROVE sites within 100 miles that can provide representative data. There are no nearby, Atlantic coast IMPROVE sites to provide data for Canaveral NS, Casa de San Marcos NM or Fort Matanzas NM, and there are no nearby inland sites for Horseshoe Bend NMP, Moores Creek NB or Ocmulgee NM. Installation of an IMPROVE monitor in a north Florida coastal park would fill a gap in the IMPROVE network, and would enhance data interpretation for a number of Southeast Coast Network parks. Parks with visibility concerns may want to consider using a less expensive, digital camera to document and interpret visibility degradation.

Congaree National Park and Fort Sumter NM have ozone monitors on-site, the rest of the Southeast Coast Network parks have one or more ozone monitors within 35 miles.

Ozone sensitive vascular plant species have been identified for sixteen of the parks in the Southeast Coast Network. Ozone concentrations are high enough in all parks that foliar injury surveys may be warranted. Black cherry and milkweed are good candidates for such surveys.

Relevant Websites

NPS Air Inventory (Air Atlas) - http://www2.nature.nps.gov/ard/gas/
NADP - http://nadp.sws.uiuc.edu/
CASTNet - http://www.epa.gov/castnet/
IMPROVE - http://vista.cira.colostate.edu/improve/
Ozone - http://www.epa.gov/air/data/index.html

Tables

Table A11-1. Summary of air quality issues in Southeast Coast Network Parks. ["↑", Increasing; "↓", Decreasing; "NT", No Trend; "Y", Yes; "N", No; "○", Frequent or consistently surpasses air quality thresholds; "○", surpasses or infrequently surpasses air quality thresholds; "-", either does not surpass air quality thresholds or no data are available; "L", Low; "M", Medium; "H", High].

		CAHA	CANA	CALO	CASA / FOMA	CHAT	CONG	CUIS	FOFR	FOPU	FOSU / CHPI	HOBE	KEMO	MOCR	OCMU	TIMU / FOCA
Wet Deposition																
Ammonium	Deposition		↑		NT		↑					NT		↑	NT	NT
	Concentration		↑		NT		↑					↑		↑	NT	NT
Nitrate	Deposition		↑		NT							↑		NT	NT	NT
	Concentration		↑		NT							↑		NT	NT	NT
Sulfate	Deposition		NT		↓							↓		↓	↑	↓
	Concentration		NT		↓							↓		↓	↑	↓
Dry Deposition																
Nitrogen	Overall dry deposition			NT								NT		NT	↑	
	Percentage of total N that is dry			32								36		37	42	
Sulfur	Overall dry deposition			NT								↓		NT	↓	
	Percentage of total S that is dry			36								41		34	42	
Surface Water Chemistry																
Acidification	Concern for Park	N	N	N	N		Y	N	N	N		N	N	Y	N	N
Metals	Potential aerial deposition						Y			Y		Y	Y	Y	Y	Y
Nutrients	Potential aerial deposition	N	N	N	N		N	N	N	N		N	N	N	n	N
Ozone																
Sum06	Frequency standard surpassed	●	○	●	●	●	○	○	○	○	○	●	●	●	●	○
W126	Frequency standard surpassed	○	-	○	-	●	○	-	-	-	-	●	●	○	●	-
Foliar Injury	Risk based on conditions	M	L	M	M/L	H	L	L	L	L	L	H	H	M	H	L

Table A11-2. Plant species in the Southeast Coast Network that are "very sensitive" to ozone.

Code	Scientific Name	Common Name	Family
AIAL	*Ailanthus altissima*	Tree-of-heaven	Simaroubaceae
ALRU2	*Alnus rubra*	Red alder	Betulaceae
AMAL2	*Amelanchier alnifolia*	Saskatoon serviceberry	Rosaceae
APAN2	*Apocynum androsaemifolium*	Spreading dogbane	Apocynaceae
ARDO3	*Artemisia douglasiana*	Mugwort	Asteraceae
ASAC6	*Aster acuminatus*	Whorled aster	Asteraceae
ASEN2	*Aster engelmannii*	Engelmann's aster	Asteraceae
ASEX	*Asclepias exaltata*	Tall milkweed	Asclepiadaceae
ASMA2	*Aster macrophyllus*	Big-leaf aster	Asteraceae
ASPU5	*Aster puniceus*	Purple-stemmed aster	Asteraceae
ASQU	*Asclepias quadrifolia*	Four-leaved milkweed	Asclepiadaceae
ASSY	*Asclepias syriaca*	Common milkweed	Asclepiadaceae
ASUM	*Aster umbellatus*	Flat-toppped aster	Asteraceae
FRAM2	*Fraxinus americana*	White ash	Oleaceae
FRPE	*Fraxinus pennsylvanica*	Green ash	Oleaceae
GEAM4	*Gentiana amarella*	Northern gentian	Gentianaceae
LIST2	*Liquidambar styraciflua*	Sweetgum	Hamamelidaceae
LITU	*Liriodendron tulipifera*	Yellow-poplar	Magnoliaceae
OEEL	*Oenothera elata*	Evening primrose	Onagraceae
PAQU2	*Parthenocissus quinquefolia*	Virginia creeper	Vitaceae
PHCA11	*Physocarpus capitatus*	Ninebark	Rosaceae
PHCO7	*Philadelphus coronarius*	Sweet mock-orange	Hydrangeaceae
PIJE	*Pinus jeffreyi*	Jeffrey pine	Pinaceae
PIPO	*Pinus ponderosa*	Ponderosa pine	Pinaceae
PIST	*Pinus strobus*	Eastern white pine	Pinaceae
PLOC	*Platanus occidentalis*	American sycamore	Platanaceae
POTR5	*Populus tremuloides*	Quaking aspen	Salicaceae
PRPE2	*Prunus pensylvanica*	Pin cherry	Rosaceae
PRSE2	*Prunus serotina*	Black cherry	Rosaceae
RHCO13	*Rhus copallina*	Flameleaf sumac	Anacardiaceae
RHTR	*Rhus trilobata*	Skunkbush	Anacardiaceae
RUAL	*Rubus allegheniensis*	Allegheny blackberry	Rosaceae
RUHI2	*Rudbeckia hirta*	Black-eyed susan	Asteraceae
RULA3	*Rudbeckia laciniata*	Cut-leaf coneflower	Asteraceae
SAAL5	*Sassafras albidum*	Sassafras	Lauraceae
SACA12	*Sambucus canadensis*	American elder	Caprifoliaceae
SAME5	*Sambucus mexicana*	Blue elderberry	Caprifoliaceae
SESE2	*Senecio serra*	Tall butterweed	Asteraceae
VILA8	*Vitis labrusca*	Northern fox grape	Vitaceae

Table A11-3. Plant species in the Southeast Coast Network that are "slightly sensitive" to ozone.

Code	Scientific Name	Common Name	Family
ACMA3	*Acer macrophyllum*	Bigleaf maple	Aceraceae
ACNE2	*Acer negundo*	Boxelder	Aceraceae
ACRU	*Acer rubrum*	Red maple	Aceraceae
AEGL	*Aesculus glabra*	Ohio buckeye	Hippocastanaceae
AEOC2	*Aesculus octandra*	Yellow buckeye	Hippocastanaceae
BEAL2	*Betula alleghaniensis*	Yellow birch	Betulaceae
BEPO	*Betula populifolia*	Gray birch	Betulaceae
BRTE	*Bromus tectorum*	Cheatgrass	Poaceae
CECA4	*Cercis canadensis*	Redbud	Fabaceae
CLLU	*Cladrastis lutea*	Yellowwood	Fabaceae
COFL2	*Cornus florida*	Flowering dogwood	Cornaceae
GLNU	*Glyceria nubigena*	Manna grass	Poaceae
KRMO	*Krigia montana*	Mountain dandelion	Asteraceae
LADE2	*Larix decidua*	European larch	Pinaceae
_LALE0	*Larix leptolepis*	Japanese larch	Pinaceae
PIBA2	*Pinus banksiana*	Jack pine	Pinaceae
PINI	*Pinus nigra*	Austrian pine	Pinaceae
PIRA2	*Pinus radiata*	Monterey pine	Pinaceae
PIRI	*Pinus rigida*	Pitch pine	Pinaceae
PITA	*Pinus taeda*	Loblolly pine	Pinaceae
PIVI2	*Pinus virginiana*	Virginia pine	Pinaceae
RHGL	*Rhus glabra*	Smooth sumac	Anacardiaceae
RHTY	*Rhus typhina*	Staghorn sumac	Anacardiaceae
ROPS	*Robinia pseudoacacia*	Black locust	Fabaceae
RUID	*Rubus idaeus*	Red raspberry	Rosaceae
RUNU2	*Rugelia nudicaulis*	Rugel's ragwort	Asteraceae
SAAR13	*Saxifraga arguta*	Saxifrage	Saxifragaceae
SAGO	*Salix gooddingii*	Gooding's willow	Salicaceae
SASC	*Salix scouleriana*	Scouler's willow	Saliaceae
SPAL	*Spartina alterniflora*	Smooth cordgrass	Poaceae
SPVA2	*Spiraea x vanhouttei*	Vanhoutte spirea	Rosaceae
SYAL	*Symphoricarpos albus*	Common snowberry	Caprifoliaceae
_SYCHX	*Syringa x chinensis*	Chinese lilac	Oleaceae
SYVU	*Syringa vulgaris*	Common lilac	Oleaceae
TIAM	*Tilia americana*	American basswood	Tiliaceae
_TIEU0	*Tilia euchlora*	Crimean linden	Tiliaceae
TIPL	*Tilia platyphyllos*	Bigleaf linden	Tiliaceae
TORA2	*Toxicodendron radicans*	Poison-ivy	Anacardiaceae
VEOC	*Verbesina occidentalis*	Crownbeard	Asteraceae
VIRI	*Vitis riparia*	Riverbank grape	Vitaceae

Code	Scientific Name	Common Name	Family
VIVI5	*Vitis vinifera*	European wine grape	Vitaceae

Figures

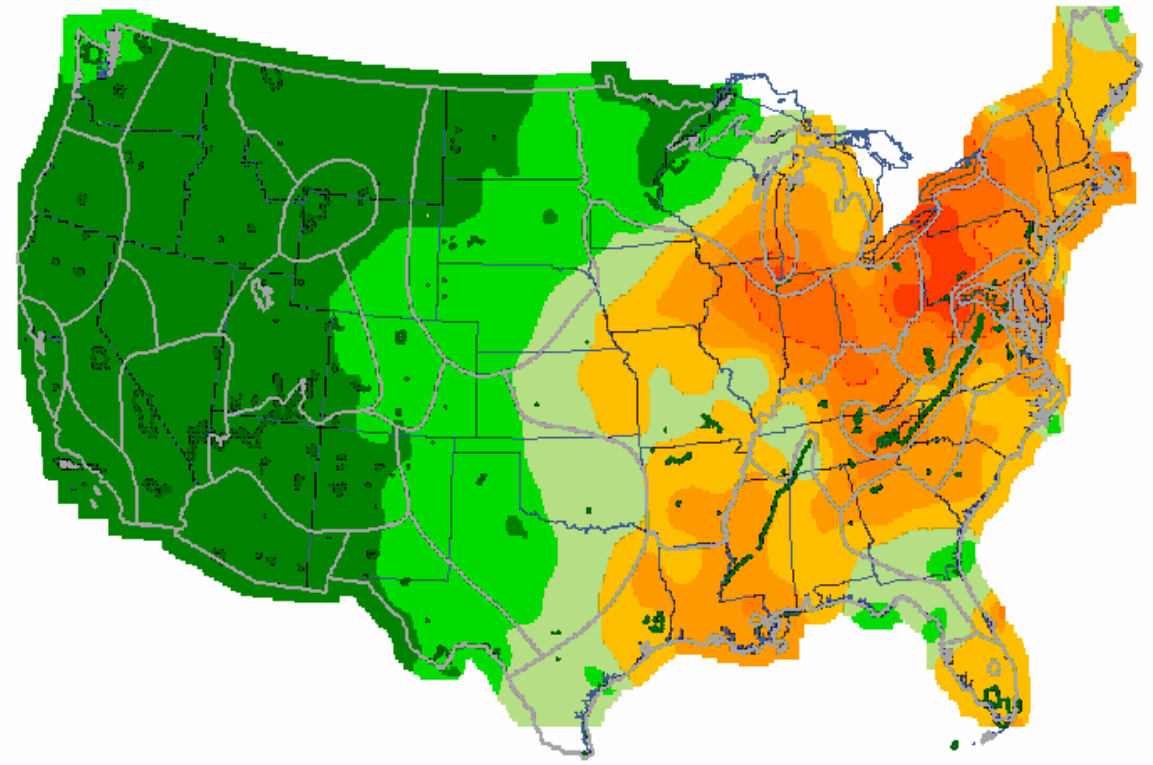

Figure A11-1. Average annual wet deposition of sulfate 1995-2000. Areas in red or orange have higher concentrations than those that are green.

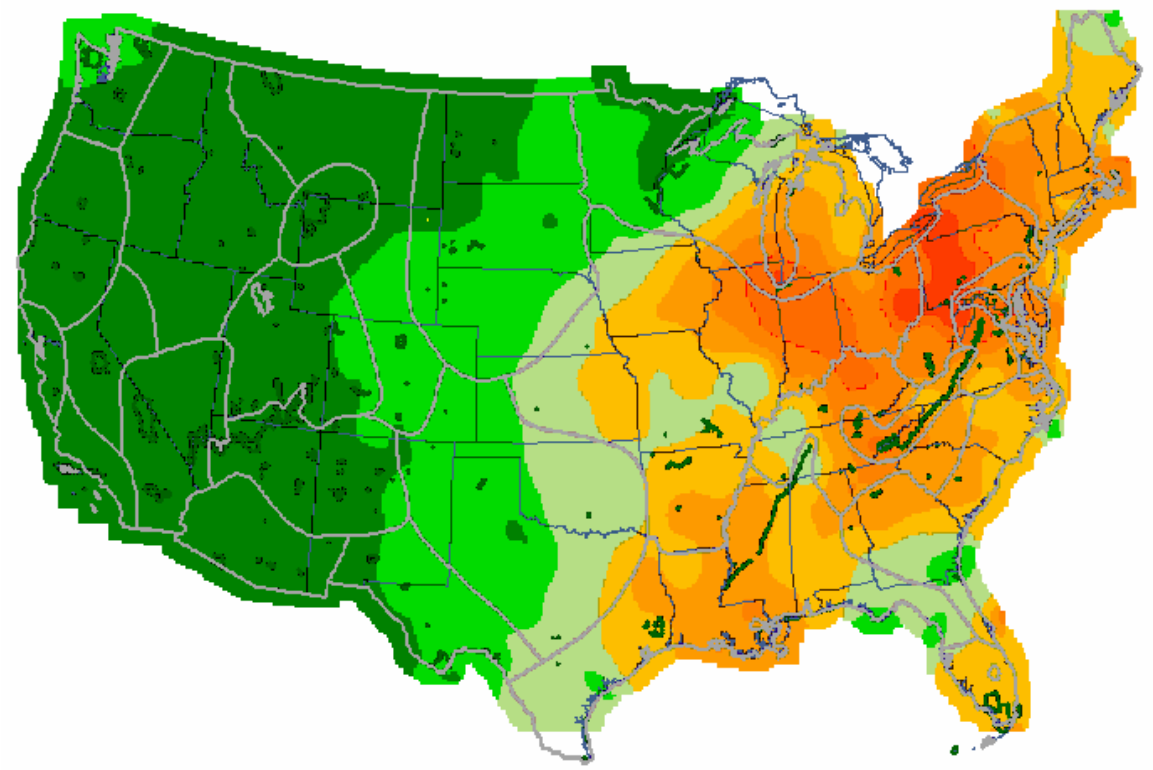

Figure A11-2. Average annual wet deposition of nitrate, 1995-2000. Areas in red or orange have higher concentrations than those that are green.

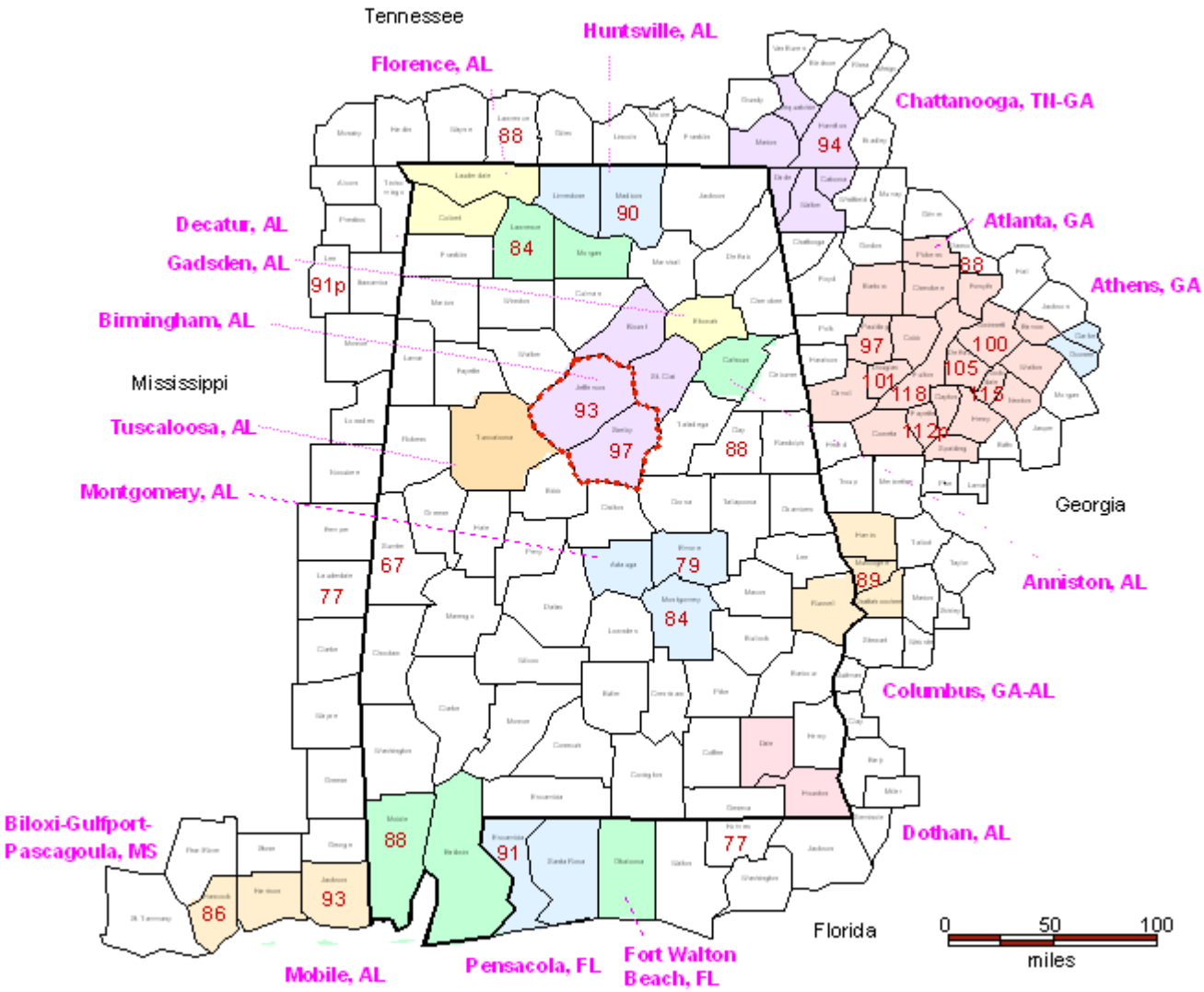

Figure A11-3. Alabama 1997-1999 8-hour Ozone design values in parts per billion. Counties with design values greater than or equal to 85 parts per billion are violating the standard. Red lines indicate counties of current or previous nonattainment. Counties in consolidated metropolitan statistical areas (C/MSAs) are shown in color. ["h", data from 1996-1998; "p", two years of data only and the county has a potential to violate].

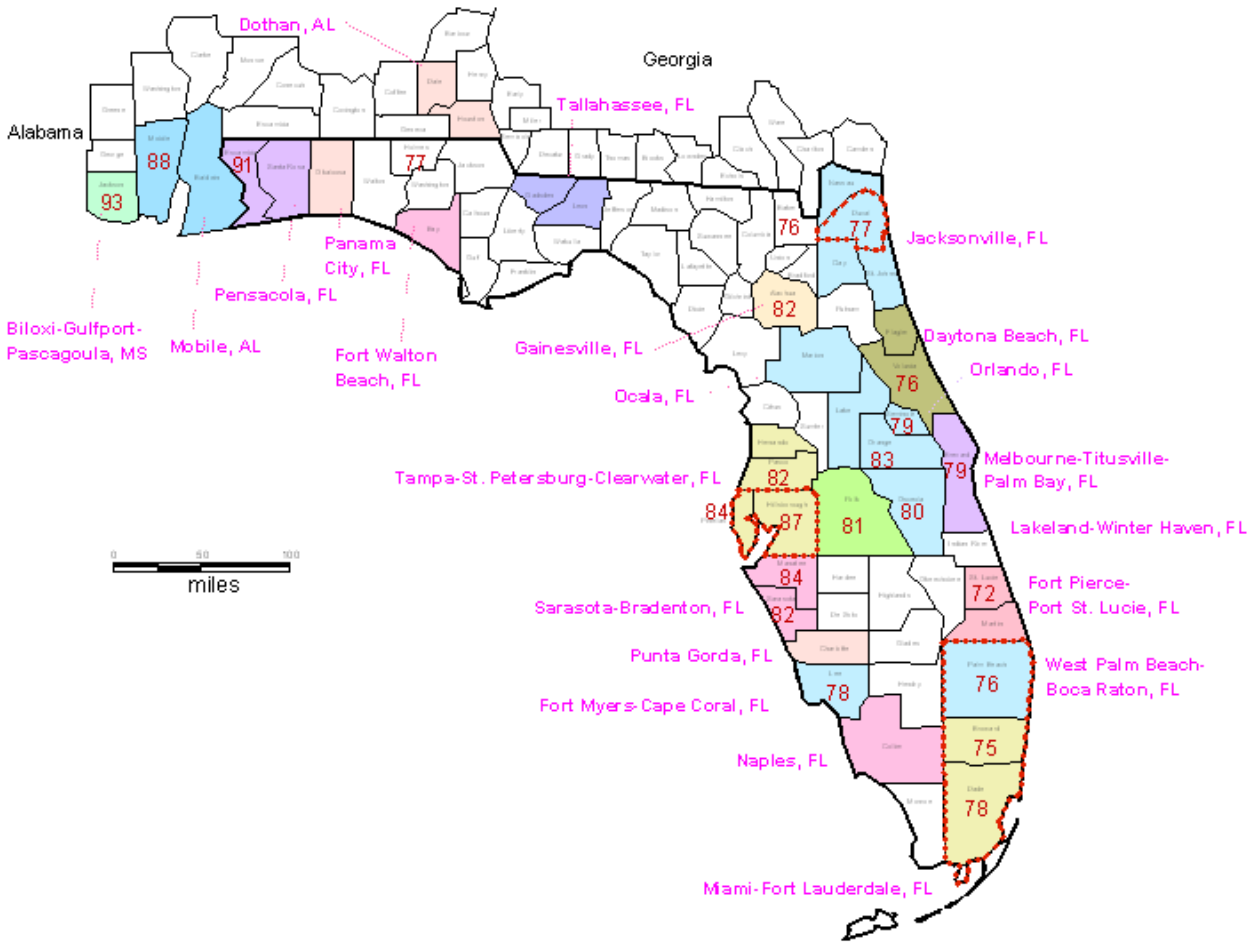

Figure A11-4. Florida 1997-1999 8-hour Ozone design values in parts per billion. Counties with design values greater than or equal to 85 parts per billion are violating the standard. Red lines indicate counties of current or previous nonattainment. Counties in consolidated metropolitan statistical areas (C/MSAs) are shown in color. ["h", data from 1996-1998; "p", two years of data only and the county has a potential to violate].

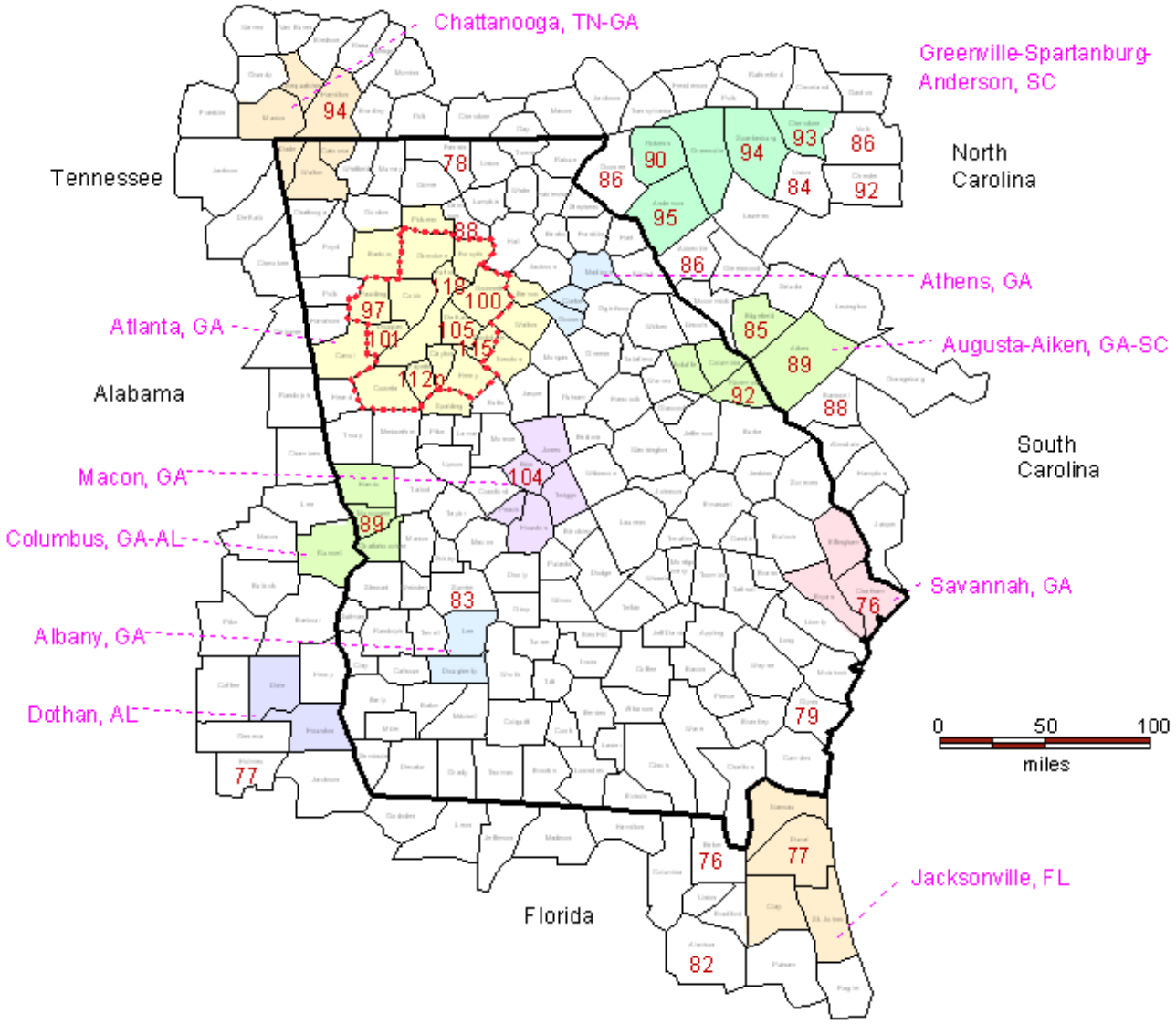

Figure A11-5. Georgia 1997-1999 8-hour Ozone design values in parts per billion. Counties with design values greater than or equal to 85 parts per billion are violating the standard. Red lines indicate counties of current or previous nonattainment. Counties in consolidated metropolitan statistical areas (C/MSAs) are shown in color. ["h", data from 1996-1998; "p", two years of data only and the county has a potential to violate].

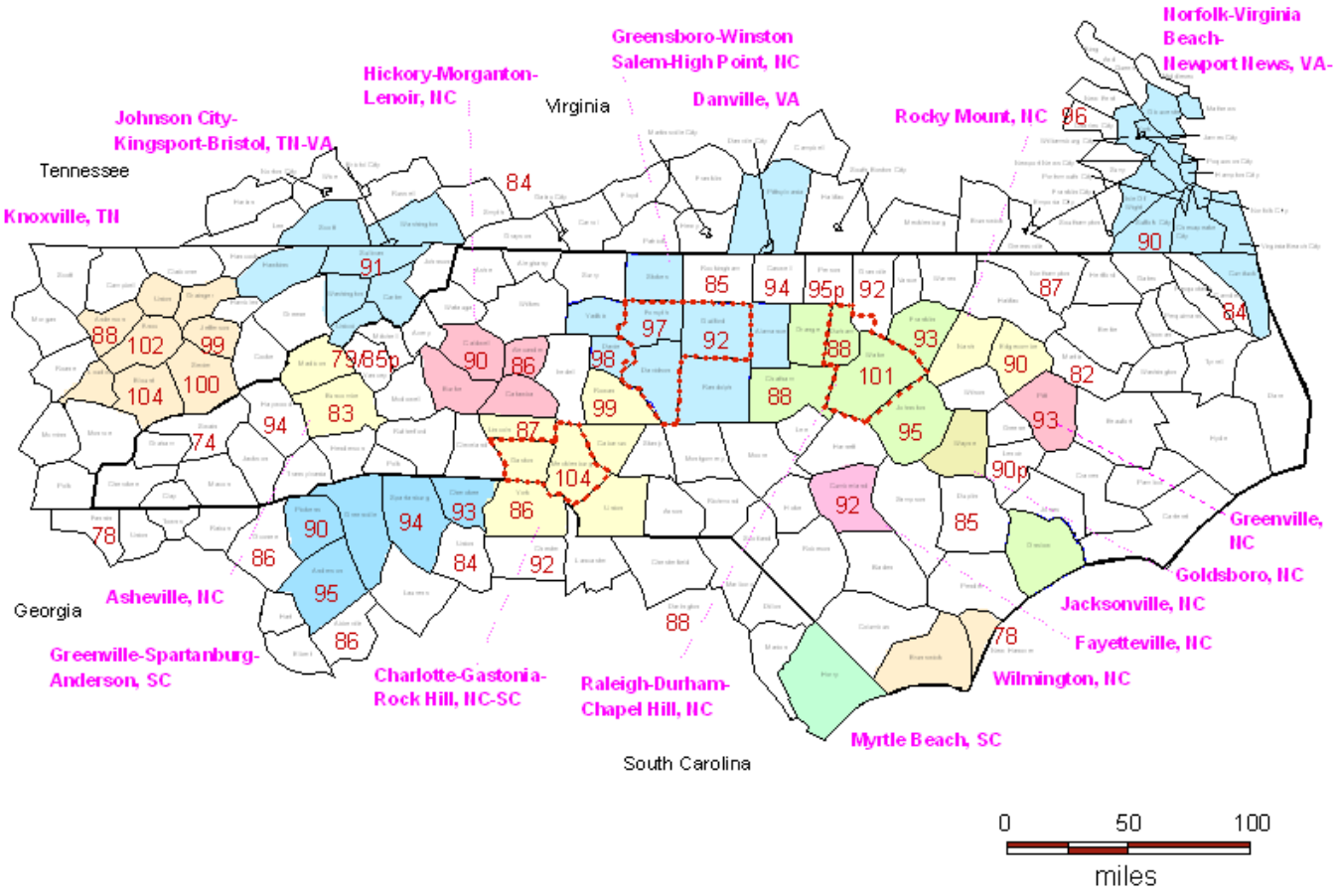

Figure A11-6. North Carolina 1997-1999 8-hour Ozone design values in parts per billion. Counties with design values greater than or equal to 85 parts per billion are violating the standard. Red lines indicate counties of current or previous nonattainment. Counties in consolidated metropolitan statistical areas (C/MSAs) are shown in color. ["h", data from 1996-1998; "p", two years of data only and the county has a potential to violate].

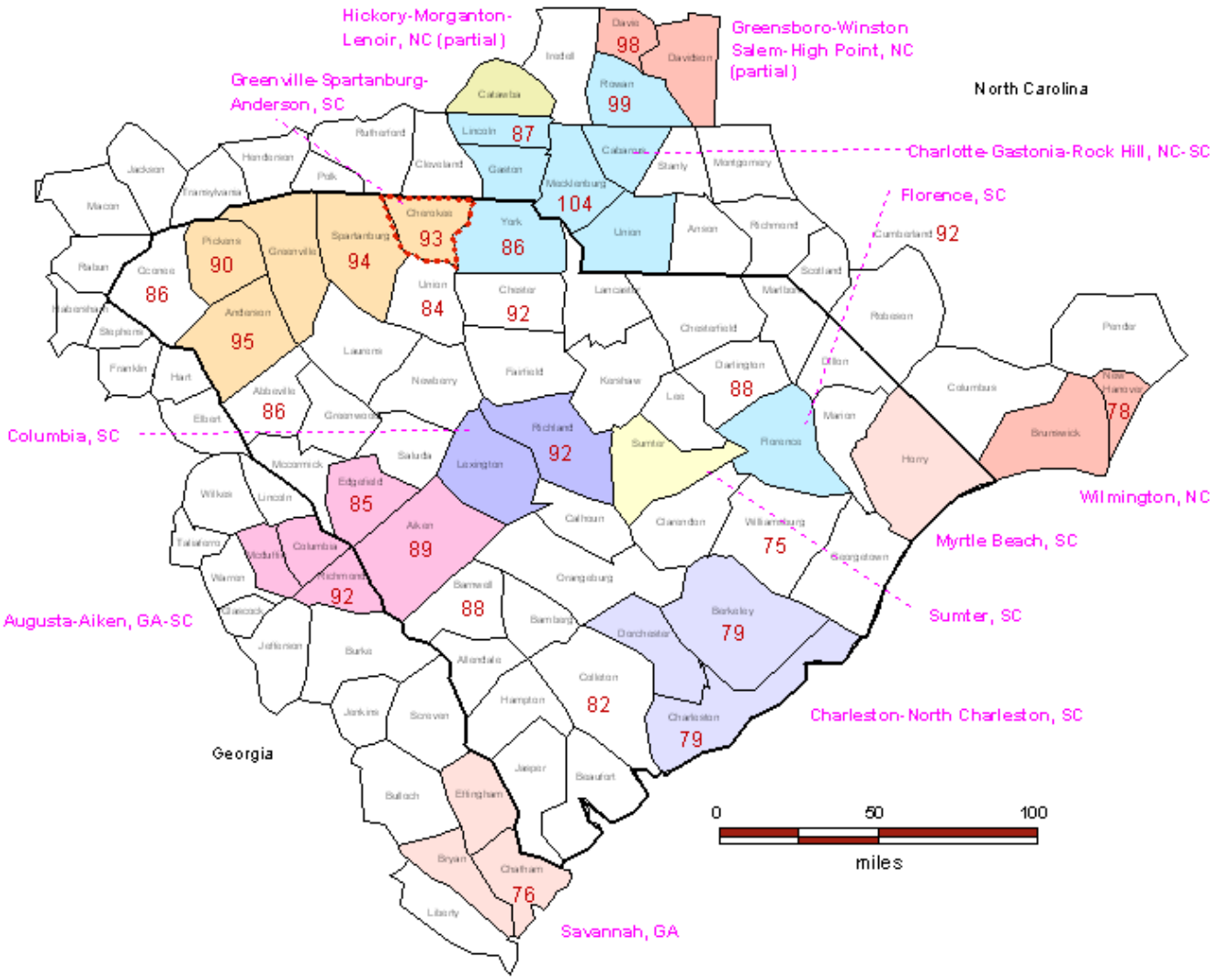

Figure A11-7. South Carolina 1997-1999 8-hour Ozone design values in parts per billion. Counties with design values greater than or equal to 85 parts per billion are violating the standard. Red lines indicate counties of current or previous nonattainment. Counties in consolidated metropolitan statistical areas (C/MSAs) are shown in color. ["h", data from 1996-1998; "p", two years of data only and the county has a potential to violate].

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